REMARKS

File History

In the Final Office action of 5/18/2006, the following allowances, rejections, objections, requirements and other actions appear to have been made:

- **Claims 2-3, 13-15, 30, 36-37, 39-40** were indicated to contain allowable subject matter but were objected to for being dependent upon a rejected base claim.

- **Claims 1, 3, 4, 7-9, 16, 31-35, 38** were rejected under 35 USC §102(b) as being fully anticipated by **Chen et al.** (U.S. 5,661,083) or alternatively under 35 USC §103(a) as being obvious over Chen. (*Note: from the reasons given for rejection, it is obvious the Examiner meant claim 4 rather than 3.*)

- **Claims 16-18** were rejected under 35 USC §103(a) as being obvious over **Chen**.

- **Claims 10-12, 27-28** were rejected under 35 USC §103(a) as being obvious over **Chen** in view of **Wolf et al.** (Silicon Processing for the VLSI Era, pages 546-547).

- **Claims 24-26** were rejected under 35 USC §102(e) as being fully anticipated by **Chiu et al.** (U.S. 2004/0157444 based on 2/10/2003 filing date).

- **Claims 5-6** were rejected under 35 USC §103(a) as being obvious over **Chen** in view of **Tang** (US 6,156,485 issued 12/5/2000).

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Summary of Current Response

Claims 3-5 are amended.

Arguments and evidence are presented concerning support to amendment to the claims and concerning the applied art and its proposed combination.

Request for entry of Amendment after Final to Claims 3-5

Claim 3 was indicated to be allowable if rewritten into independent form including all limitations of its base claim. This is done here.

Claim 4 is proposed to be amended to depend from 3 rather than 1. No additional examination is need since claim 3 is allowable. Claim 5 is proposed to be amended to depend from 3 rather than 1. No additional examination is need since claim 3 is allowable. Moreover, this would make Claim 6/5/3 also allowable. Entry is respectfully requested.

Applicants' Overview of Outstanding Office Action

Applicant sees the outstanding Office action of 5/18/2006 as having the following noteworthy features (1)-(2):

(1) There is no showing that the hardmask/ARC interface 208/206 of Chen certainly contains a "micromasking residue" and "nodules" with anchor bases as recited in the claims and reasonably interpreted in view of the specification. It is demonstrated below that Chen's debris 214 (Fig. 2B) is not the same as debris 114 (Fig. 1A). It is respectfully submitted that the fact finding process is flawed due to confusion between different debris compositions 114 and 214.

(2) With respect to Chiu and Claim 26, there is no motivation for the ordinary artisan to replace the required, amorphous carbon layer 12 of Chiu with something else (i.e. TiN).

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Are nodules inherently formed in "all" interface regions?

All outstanding rejections that are based on Chen '083 rely on a speculative proposition of inherency. More specifically at OA page 3, last 4 lines et sequa, the PTO asserts:

> Chen is silent about ... nodules ... [H]owever, it would appear that the oxide etch process of Chen would **inherently** result in ***exposure*** of nodules ... because Chen discloses the same structure as the one claimed ... [namely] an oxide layer overlying a metal-containing ARC layer and wherein the oxide has been patterned to expose the ARC layer. The method of Chen removes those nodules by exposure to the N2/H2/**CF4**. This **chemistry** certainly reacts with a first metal element of the ... ARC layer (**Ti**) to produce volatile products [*Emphasis added.*]

It submitted respectfully that Claim 1 does not recite "nodules" as a term that can be taken in isolation. Rather, Claim 1 defines the nodules as "having a base anchor portion and an upper body portion" and as "containing one or more oxides" **and as being part of** a "micromasking residue remaining within an exposed interface region of an oxide-based hardmask layer and an underlying metal-containing anti-reflection coating layer (ARC layer) **after** the hardmask layer has been patterned". [*Emphasis added.*]

Thus from the plain and ordinary meaning of the terms found in Claim 1, if a prima facie case of anticipation is to be made, the reference (e.g., Chen '083) must have a "residue" that can provide the recited "micromasking" function where the micromasking residue contains the defined nodules.

It is well settled that even under a broad and reasonable construction of claims as carried out by the PTO, all terms in the claim must be considered, and not in isolation but rather in light of the specification as would be done by a person of ordinary skill at the relevant time. Applicant understands that limitations within the specification should not be imported into the claims when broadly construing the claims during prosecution. Applicant understands that it is sometimes a fine line between whether the specification is being used to define a term appearing in the claims and whether additional limitations are being imported into the claims. However, in the present case, the claim language itself (e.g., Claim 1) clearly recites the "micromasking residue". Thus it is incumbent upon the PTO to demonstrate that Chen has such micromasking residue; and not by resort to speculation and possibilities, but rather as a matter of scientific certainty.

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Note that "Inherency ... may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." In re Oelrich, 666 F.2d 578, 581, 212 USPQ 323, 326 (CCPA 1981).

Before looking at details of Chen '083, it should be noted that the present specification does not guarantee that the so-called nodules (and micromasking residue which contains them) will always be formed anytime one has a combination of any oxide hardmask and any metal-containing ARC. Quite to the contrary, the specification notes at paragraph [0006] that:

> ... more particularly, Plasma-Enhanced TEOS (**PE-TEOS**) might be used for forming a blank hardmask layer on top of a titanium (Ti) containing ARC layer (anti-reflection coating).... However, it has been observed that a significant amount of micromasking residue may be left behind on the Ti-containing ARC layer and that this micromasking residue can interfere with proper etching of the underlying metal (e.g., aluminum) layer. [*Emphasis added.*]

Those skilled in the art will understand from this that Applicants have found something peculiar with regard to use of the PE-TEOS process in combination with the Ti-containing ARC composition. Some mechanism(s) is/are present for producing the observed micromasking residue and its micromasking effects. Applicants have not determined exactly what it is in the PE-TEOS process and/or ARC composition that tends to produce this micromasking residue or whether all hardmask-forming processes in combination with all metal-containing ARC compositions tend to produce this micromasking residue. Instead they analyzed the composition of the residue produced in their experiments (produced when using the PE-TEOS process) and used deductive reasoning to determine why the normal sequence of oxide-removing etch flowed by ARC-patterning etch failed to remove this micromasking residue and thus led to the observed micromask-induced shorts (or near shorts) in the underlying metal layer. As explained in the specification, it is postulated that inversion of the oxide and metal materials produces the observed resistance of the micromasking residue to the normal sequence of oxide-removing etch followed by the ARC-patterning etch.

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Applicant's Detailed Reading of the Chen reference

Chen not only fails to teach, suggest or imply that a micromasking residue forms in his process, Chen actually implies that the "polymeric debris" 214 of Fig. 2B does not have micromasking properties. Chen further implies that the "polymeric debris" 214 does not include any anchored nodules.

At the outset, Applicant submits that the PTO may have confused debris 114 (Fig. 1A) with the "polymeric debris" 214 of Fig. 2B. Chen makes it clear they are not the same. Note that in Chen Fig. 2B, punch-through of aperture 212 into etch stop 206 was not allowed to occur. By contrast, in Chen Fig. 1A, punch-through of aperture 112 through etch stop 106 and reaching metal layer 104 was allowed to occur (irrespective of the schematic showing of debris 114 coating the floor of exposed metal layer 104). Chen explains that punch-through of aperture 112 into metal layer 104 causes metal to be ejected into the debris 114 thus changing the composition of the debris and making it difficult to remove. However, in the case of Fig. 2B, the metal layer 204 has not yet been reached and therefore, debris 214 of Fig. 2B is not the same as 114 of Fig. 1A. The $N_2/H_2/CF_4$ etch of col. 4, line 31 is not performed in the presence of debris 114, but rather in the presence of different debris 214.

Referring to the details of Chen Fig. 2B, one reason why Chen's "polymeric debris" 214 does not include any anchored nodules satisfying the limitations of Claim 1 is because the same one polymeric material coats the sidewalls of the oxide 208 as aperture 212 develops and before it ever reaches the ARC layer (TiN) 206. Thus there can be no significant amount of metal in debris 214. This can be appreciated from Chen's explanation at col. 4, lines 8-20:

> Following the removal of the photoresist portion of the device, the dielectric layer 208 is etched using standard methodologies to increase the size of the via which now extends to the etch stop layer 206 as shown in FIG. 2B. The via may be formed using either anisotropic etching or a combination isotropic and anisotropic etching. In one embodiment, both isotropic and anisotropic etching is used to form this portion of the via. The etching is allowed to continue until substantial contact is made with the etch stop layer 206. Also formed **during** the etching process is a **coating of polymeric debris 214** which is deposited typically along the sides and floor of the via. [*Emphasis added.*]

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The sidewall of oxide layer 208 contains only oxide, no substantial amount of metal (Ti) as might be found in and ejected from the etch stop layer 206. The single ("a") coating of polymeric debris 214 is said to form "during" the etching process, this indicating that the

debris forms in the nascent via even before the recited "substantial contact" is made with the not-yet-etched, etch stop layer 206 (TiN or TiW). Moreover, debris 214 cannot contain aluminum because Al layer 204 has not been reached in Fig. 2B. By contrast, debris 114 is said to contain atoms of aluminum at col. 1, line 56 because punch-through to the aluminum has occurred in Fig. 1A. Chen characterizes the debris 214 of Fig. 2B as being a peculiar "water-soluble" polymer that is easy to remove at col. 5, lines 19-23. Thus it is abundantly clear that debris compositions 114 and 214 are not the same.

In terms of the composition of the polymeric debris 214, nowhere does Chen suggest that the debris 214 of Fig. 2B contains nodules having anchored bases. Chen mentions only that trace "atoms" of aluminum may be observed in the debris composition 114 **IF** etching is allowed to punch completely through the etch stop layer and to punch into the underlying metal layer 104 per Fig. 1A. See col. 1, lines 39-50 which state:

> Second, [avoidance of punch through is traditionally done because] etching through the etch stop layer [**and in]to the underlying metal layer** causes the formation of polymeric debris 114 that is extremely difficult to remove from the via. The polymeric debris [114] is formed as a result of the plasma bombardment of the semiconductor device during the formation of the via and typically includes as its components the chemical species being used to create the plasma in addition to **atoms** from the metal layer [104], as well as atoms from the oxide, etch stop [106], and photoresist layers. [*Emphasis and bracketed text added.*]

Note that the primary concern is the ejection of aluminum metal atoms from metal layer 104.

Between Chen's "complete" removal of the etch stop material 206 by use of a first $N_2/H_2/CF_4$ process at col. 4, lines 21-47 and removal of the debris 214 by use of a second and different $N_2/H_2/CF_4$ process described at col. 4, line 61-et sequa, there is an oxygen-based bulk ashing of the photoresist at col. 4, line 54. Chen does not describe what happens to the "polymeric" debris 214 during the oxygen-based bulk ashing process. According to Chen, it is the avoidance of using a DC bias in the second $N_2/H_2/CF_4$ process (col. 4, line 61-et sequa) that prevents metal (aluminum) from being sputtered out and prevents formation of the "difficult to remove" debris 114. See col. 5, line 16. Thus Chen is in essence saying that he is keeping his debris 214 essentially free of metal content.

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Rejections are therefore based on Incorrect Findings of Fact

It is respectfully submitted that a first key error in fact finding is made at OA page 3, starting with the last word of line 3 ("For example where ... CF_4 is used ...). The OA appears to confuse debris 114 and 214 as if they were the same composition. They are not. Col. 1, lines 50-62 of Chen are describing only debris 114; namely, the one that forms in Fig. 1A when the etch stop layer 106 is composed of TiW, the metal layer 104 is composed of Al and punch-through is allowed to occur into the aluminum layer 104 by the CF4 RIE etch recipe so as to permit sputter-ejection of aluminum atoms from layer 104 into debris composition 114.

A minor error is made in the OA at page 3, line 7, namely assuming that trace "atoms" of O, Si, Ti and Al inherently translate into formation of compounds such oxides and fluorides of Ti. This is pure speculation. Typically a TiW ARC layer will be composed mostly of tungsten (W) and the fluorine in the CF4 etch gas will preferentially form a volatile tungsten-fluoride product, thus perhaps leaving a small amount of Ti behind. There is no basis for assuming that the left behind Ti will anchor to anything or form oxides and fluorides of Ti. It is respectfully submitted that the grounds of rejection make a series of unsupported assumptions.

It is respectfully submitted that a second key error of fact finding is made at the bottom of OA page 3, where it is concluded that Chen's polymeric debris 214 would most assuredly have nodules with base anchor portions simply because Chen shows a structure having an oxide (208) atop a TiN ARC that functions as an etch stop (206). Chen nowhere describes the specifics of the oxide layer 208 (how it is deposited --as is admitted by the PTO at the top of OA page 9). It is pure speculation to assume that nodules will be present.

At OA page 4, line 4, the PTO finds that this [N2/H2/CF4] chemistry will "certainly" react with the Ti in Chen's TiN ARC layer to form volatile products and that Chen's plasma "molecules" are certainly small enough to enter anchor portions of hypothesized nodules. There is no factual basis for any of these findings. First off, the N2/H2/CF4 recipe is not a chemistry practiced in isolation but rather in a specific reactor with specific pressures, temperatures and gas flows. Applicant is not willing to speculate on which permutations of these might "certainly" form volatile products of what and neither should the PTO do so without a factual basis. That said, it appears clear to Applicant that until nascent aperture 212

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makes contact with TiN layer 206 in Chen's Fig. 2B there can be no significant metal content in the debris 214. Thus the conclusion that Chen's debris 214 includes metal-containing nodules is unfounded.

Applicant does not understand the first full paragraph of OA page 4 that asserts Chen's process will "obviously" produce nodules. Clarification is respectfully requested.

Claim 7 recites "one or more additional chemically reactive agents which can react with, and volatize materials present in the base anchor portions of the residue nodules" [*Emphasis added.*] It is not understood how the rationale on OA page 4 re claim 7 addresses this. Clarification is respectfully requested.

Claim 8 recites "the second agent being sufficiently large in average mass for physical bombardment purposes to operatively weaken attachments of the base anchor portions of the residue nodules to the interface region so as to thereby encourage break away and removal of the residue nodules from the interface region" [*Emphasis added.*] Clearly by the language of Claim 8, the base anchor portions are attached to the interface region. The outstanding grounds of rejection have failed to demonstrate that Chen '083 has nodules with base anchor portions attached to the interface region.

Although Claims 5-6 are amended above for strategic reasons, Claim 1 is retained in its original broad form and Applicant reserves the right to pursue the subject matter of Claims 5-6 prior to the tactical amendment. At OA page 9, the PTO asserts that Tang '485 teaches PE-TEOS. This is factually incorrect. Tang col. 3, line 67 is discussing Lee '770. Plasma enhanced oxide (PE Ox 140 of Tang 6:16) does not inherently mean TEOS. Tang's PEOX is formed by SiH4 plus NO2 per 6:23. Tang is directed to an aluminum-copper metal layer. Tang uses a different etch process 6:32. There is no motivation other than an "obvious to try" argument and pick-and-chose for combining specific parts of Chen with Tang.

Re claims 10-12, "obvious to try" is not a valid basis of rejection and that is what the stated grounds boil down to.

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Re claim 16/8/1, Chen '083 has different debris (214), a different situation. There is no per se rule that coinciding end points of power ranges for different reaction environments are per se obvious.

Re claim 17/16/8/1, Chen '083 has different debris (214), a different situation and teaches to use a microwave reactor with no DC bias so that the aluminum will not sputter out.

Re claim 18/8/1, "obvious to try" is not a valid basis of rejection and that is what the stated grounds boil down to.

Claim 24 --- the Chiu Publication

The PTO persists with rejection of Claim 24 based on Chiu '444.

It is well settled law that:

> "It is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art." [citing *In re Wesslua*]
>
> In re Hedges 228 U.S.P.Q. 685, 687 (Fed. Cir. 1986) [*Emphasis added.*]

The prior art as a whole must be considered. The teachings are to be viewed as they would have been viewed by one of ordinary skill without aid of hindsight.

OA page 7 is a classic example of the pick-and-choose syndrome. At line 6, the PTO points to Chiu Fig. 2. At line 4, the PTO implies that layer 12 of Chiu Fig. 2 is described in paragraphs [0051] and [0056] as being "any" material including TiN. But that is not true. Paragraph [0056] nowhere mentions layer 12. Chiu paragraph [0056] is merely a continuation of the general description of ARC's as begun at paragraph [0052]. More specifically, Chiu paragraph [0056] states:

> [0056] An ARC layer is **typically** formed through a spin coating method as is **conventional** in the art followed by a thermal cure at a temperature of about 120 degrees C. for a time period of about 90 seconds to yield a blanket focusing layer when cured of a thickness of between about 300 and 1500 angstrom. A **common** ARC is TiN, which may be deposited by sputtering, **possible materials** that can be used for the ARC layer of the invention are cryolite and MgF. It must thereby also be realized that the layer of ARC **can** contain more than one layer of material. [*Emphasis added.*]

None of this negates the fact that Chiu paragraph [0051] unequivocally requires layer 12 to include a layer of *organic* ARC:

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[0051] The blanket layer 12 may be formed from any of the Anti Reflective Coating materials that are common in the art of microelectronic fabrication. **Layer 12 comprises a layer of organic ARC**, such a layer typically absorbs light, thereby minimizing reflection, making this layer suitable in an application for creating deep-submicron device features. [*Emphasis added.*]

None of the other language in Chiu negates the fact that Chiu paragraph [0072] unequivocally requires layer 12 to be "of BARC" (bottom-anti-reflective coating); which according to paragraph [0055] is some material that "can be either opaque or translucent, and yet not reflect, nor transmit electromagnetic radiation." Here is paragraph [0072]:

[0072] As an example of the removal of a layer 14 of SiON can be cited exposing layer 14 to a recipe comprising O_2, at a flow rate between 10 and 100 sccm, and N_2, at a flow rate between 10 and 100 sccm, for a period between about 30 and 60 seconds. Layer 12 **of BARC** can be removed following **the same recipe to this layer 12**. [*Emphasis added.*]

According to Chiu claims 7 and 8, the BARC is composed of CVD-deposited *amorphous carbon.*

According to Chiu paragraph [0047]: item number 12 of Fig. 1 is "a layer of ARC deposited over the surface of the oxide based layer 10; the preferred material of the invention for layer 12 is CVD **BARC comprising amorphous carbon**".

Moreover, according to Chiu paragraph [0048]: item number 14 of Fig. 1 is "a first layer of hardmask material that has been deposited over the surface of layer 12 **of ARC/CVD BARC**" [*Emphasis added.*]

In trying to argue that Chiu layer 12 is something other than what Chiu specifically teaches, the PTO is engaging in a game of hindsight substitution and arbitrary picking and choosing. Reconsideration is respectfully requested.

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It is not Applicant's job to convert the Chiu publication into something that makes full coherent sense. However, it is respectfully submitted that Applicant has demonstrated that one of ordinary skill would come to understand that interface 14/12 of Chiu Fig. 2 is a SiON/amorphous carbon interface.

Claim 24 calls for "a metal-containing anti-reflection coating layer (ARC layer)". In view of the above evidence, there is no reasonable way that an ordinary artisan can come to view layer 12 of Chiu as being a metal-containing ARC layer. Layer 12 of Chiu is clearly an organic layer composed of amorphous carbon.

At the top of page 8, the OA invokes the "principle of inherency". Applicant is not sure exactly what that means. If the PTO intends to say that Chiu inherently discloses a "method" wherein an "oxygen-poor interfacial layer" is interposed between a metal-containing ARC layer and an oxygen-containing hardmask layer, then this must be established by scientific certainty and not by resort to speculation about possibilities.

Despite the above arguments, Applicant continues to maintain that a strong question remains as to whether Chiu '444 constitutes a valid prior art reference under the legal fiction of 35 USC §102(e). 102(e) requires a §112 level of description including enablement and best mode. It is not clear that Chiu meets this level of adequate disclosure. Chiu is confusing. For example, Chiu at paragraph [0043] as continued on page 3, line 2 states that Figs. 1-6 address a "silicon based surface" while the detailed description of say, paragraph [0045] indicates it is an oxide based surface. Thus there is a question whether Chiu satisfies all the adequate "description" requirements of 35 USC §112. The mere fact that an application early published under 35 USC §122(b) does not of itself validate that the publication merits status as a 102(e) reference. 35 USC §102(e) requires that the publication adequately "describe" the invention ("(e) the invention was described in ...").

CONCLUSION

In light of the foregoing, Applicant respectfully submits that the outstanding grounds of rejection are overcome. Reconsideration and allowance are respectfully requested. Should any other action be contemplated by the Examiner, it is respectfully requested that he/she contact the undersigned at (408) 392-9250 to discuss the application.

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The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 50-2257 for any matter in connection with this response, including any fee for extension of time and/or fee for additional claims, which may be required.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on __August 4__, 2006.

8/4/06

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